CAN

Getting Started with Your PXI-8461 or PXI-8460 and the NI-CAN™ Software for Windows NT

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Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Notices to User: ***Changes or modifications not expressly approved by National Instruments could void the user's authority to operate the equipment under the FCC Rules.***

This device complies with the FCC rules only if used with shielded interface cables of suitable quality and construction. National Instruments used such cables to test this device and provides them for sale to the user. The use of inferior or nonshielded interface cables could void the user's authority to operate the equipment under the FCC rules.

If necessary, consult National Instruments or an experienced radio/television technician for additional suggestions. The following booklet prepared by the FCC may also be helpful: *Interference to Home Electronic Entertainment Equipment Handbook.* This booklet is available from the U.S. Government Printing Office, Washington, DC 20402.

Canadian Department of Communications

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

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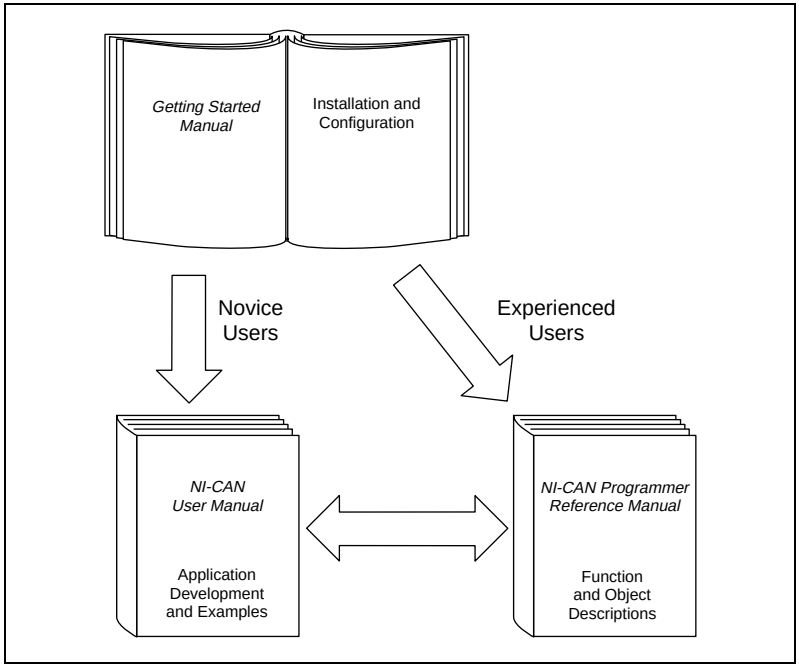
About This Manual

This manual contains instructions to help you install and configure your PXI-8461 (one port and two port) or PXI-8460 (one port or two port) and the NI-CAN software for Windows NT. This manual uses PXI-8461 or PXI-8460 to refer to both the one port and two port versions of the boards.

This manual assumes that you are already familiar with Windows NT.

How To Use the Manual Set



Use this getting started manual to install and configure your PXI-8461 or PXI-8460 and the NI-CAN software for Windows NT.

Use the *NI-CAN User Manual* to learn the basics of CAN and how to develop an application program. The user manual also contains debugging information and detailed examples.

Use the *NI-CAN Programmer Reference Manual* for specific information about each NI-CAN function and object, including format, parameters, and possible errors.

Conventions

The following conventions appear in this manual:

» The **»** symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.

This icon denotes a note, which alerts you to important information.

This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash.

bold Bold text denotes items that you must select or click on in the software, such as menu items and dialog box options. Bold text also denotes parameter names.

italic Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.

`monospace` Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames and extensions, and code excerpts.

`monospace italic` Italic text in this font denotes text that is a placeholder for a word or value that you must supply.

Related Documentation

The following documents contain information that you may find helpful as you read this manual:

- ANSI/ISO Standard 11898-1993, *Road Vehicles—Interchange of Digital Information—Controller Area Network (CAN) for High-Speed Communication*
- ANSI/ISO Standard 11519-2-1994, *Road Vehicles—Low-Speed Serial Data Communication—Part 2: Low-Speed Controller Area Network (CAN)*
- *CAN Specification Version 2.0*, 1991, Robert Bosch Gmbh., Postfach 500, D-7000 Stuttgart 1
- CiA Draft Standard 102, Version 2.0, *CAN Physical Layer for Industrial Applications*
- *CompactPCI Specification*, Revision 2.0, PCI Industrial Computers Manufacturers Group
- *DeviceNet Specification, Version 2.0*, Open DeviceNet Vendor Association
- *PXI Specification*, Revision 1.0, National Instruments Corporation

1

Introduction

This chapter lists what you need to get started, provides an overview of the PXI hardware and the NI-CAN software for Windows NT, and describes optional equipment you can order.

What You Need to Get Started

Make sure you have all of the following items before you attempt to install the hardware and software:

- ❑ Windows NT 3.51 or later installed on your computer
  - – PXI-8461 one port
  - – PXI-8461 two port
  - – PXI-8460 one port
  - – PXI-8460 two port
- ❑ 3.5 in., high-density (1.44 MB) disks, which are included in your kit:
  - – *NI-CAN Software for Windows 95/98/NT*
    Version 1.3
    (Disk x of 3)
- ❑ CAN interface cables that meet the requirements in Appendix B, *Cabling Requirements for PXI-8461 High-Speed CAN* or Appendix C, *Cabling Requirements for PXI-8460 Low-Speed CAN*.

Hardware Overview

The PXI-8461 and PXI-8460 (one port and two port) are software configurable and compliant with the *PXI Specification* and *CompactPCI Specification*. With a PXI-8461 or PXI-8460 board, you can make your PXI or CompactPCI chassis communicate with and control CAN devices.

The PXI-8461 physical layer fully conforms to the ISO 11898 physical layer specification for CAN and is optically isolated to 500 V. The PXI-8460 physical layer conforms to the ISO 11519-2 physical layer

specification for CAN and is also optically isolated to 500 V. CAN interfacing is accomplished using the Intel 82527 CAN controller chip. The PXI-8461 supports a wide variety of transfer rates up to 1 Mb/s. The PXI-8460 supports rates up to 125 kb/s. The CAN physical layer on the PXI-8461 and PXI-8460 can be powered either internally (from the board) or externally (from the bus cable power). The power source for the CAN physical layer for each port is configured with a jumper.

PXI-8461 boards are available with two physical connector types:

- DB-9 D-Sub
- Combicon-style pluggable screw terminals

PXI-8460 boards are available with DB-9 D-Sub connectors.

The PXI-8461 and PXI-8460 use the Intel 386EX embedded processor to implement time-critical features provided by the NI-CAN software. The PXI-8461 and PXI-8460 communicate with the NI-CAN driver through on-board shared memory and an interrupt.

NI-CAN Software Overview

The NI-CAN software includes a native, 32-bit multitasking Windows NT kernel driver. The NI-CAN software is fully integrated into the Windows NT operating system. You can configure it through the Windows NT Control Panel and uninstall it through the Add/Remove Programs applet of the Control Panel.

The NI-CAN software for Windows NT supports the concurrent use of multiple CAN boards. For example, you can use both a PXI-8461 and PCMCIA-CAN in the same system at the same time.

The NI-CAN software, along with the PXI hardware, transforms your computer into a CAN interface with complete communications and bus management capability. The NI-CAN software includes the following components:

- Firmware (runs on embedded Intel 386EX)
- Device driver
- Diagnostic test utility
- Configuration utility

- Language interface libraries for Microsoft Visual C/C++ 2.0 or later, LabWindows/CVI 4.0 or later, and LabVIEW 4.0 or later
- Example programs that use NI-CAN functions

Optional Programming Tools

Your kit includes the NI-CAN software for Windows NT. In addition, you can order the LabWindows/CVI, LabVIEW, or BridgeVIEW software from National Instruments.

LabWindows/CVI is an interactive ANSI C development environment for building test and measurement and instrument control systems. It includes interactive code-generation tools and a graphical editor for building custom user interfaces. It also includes built-in libraries for IEEE 488.2, VXI, RS-232 control, and plug-in data acquisition. When you order LabWindows/CVI, you also get hundreds of complete instrument drivers, which are modular, source-code programs that handle the communication with your instrument so that you do not have to learn the programming details.

LabVIEW is a complete programming environment that departs from the sequential nature of traditional programming languages and features a graphical programming environment. It includes all the tools needed for instrument control, data acquisition, analysis, and presentation. LabVIEW also includes an extensive instrument driver library.

BridgeVIEW is a radical departure from traditional automation software that provides a flexible program development system for a variety of DeviceNet applications including general manufacturing, test, and control. Leveraging National Instruments patented graphical programming language G (otherwise known as LabVIEW), BridgeVIEW gives you the ability to integrate functionality in a way that is not possible with traditional automation software. In addition to the programming advantages of G, BridgeVIEW also provides a number of powerful features for the development of your industrial automation application: graphical HMI (Human Machine Interface); ease of use; fill-in-the-blank configuration utilities; HMI G Wizard for simplified HMI development; historical data collection and trending; alarm and event reporting and logging; security; and connectivity to PLCs and industrial device networks like DeviceNet.

For more information about LabWindows/CVI , LabVIEW, and BridgeVIEW, contact National Instruments.

2

Installation and Configuration

This chapter describes how to install and configure the NI-CAN software for Windows NT and the PXI-8461 or PXI-8460 hardware.

Install the NI-CAN Software

Install the NI-CAN software for Windows NT before you install your hardware.

Installation for Windows NT 3.51

1. Log on as `Administrator` or as a user with Administrator privileges. The NI-CAN setup program must have `Administrator` privileges because the program modifies the configuration registry of your system.
2. Insert the *NI-CAN Software for Windows 95/98/NT (Disk 1 of 3)* into an unused drive.
3. In the **Run** dialog box, type the following:

   x`:\setup`

   where *x* is the letter of the drive containing the disk (usually `a` or `b`).
4. Shut down Windows NT and turn off your computer when the setup is complete.
5. Proceed to the section *Install the Hardware*.

Installing for Windows NT 4.0

1. Log on as `Administrator` or as a user with Administrator privileges. The NI-CAN setup program must have `Administrator` privileges because the program modifies the configuration registry of your system.
2. Select **Start»Settings»Control Panel**.

3. Double-click on the **Add/Remove Programs** icon in the Control Panel to launch the Add/Remove Programs applet. A dialog box similar to the one in Figure 2-1 appears.

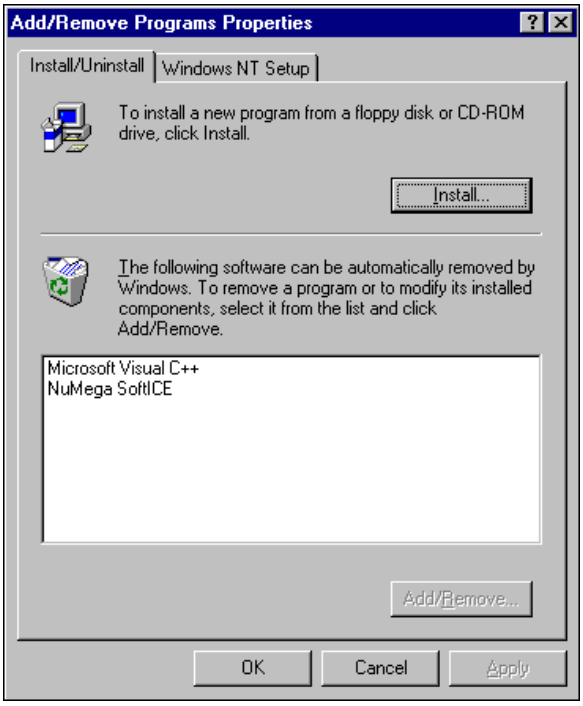

Add/Remove Programs Properties
Install/Uninstall
Windows NT Setup
To install a new program from a floppy disk or CD-ROM drive, click Install.
Install...
The following software can be automatically removed by Windows. To remove a program or to modify its installed components, select it from the list and click Add/Remove.
Microsoft Visual C++
NuMega SoftICE
Add/Remove...
OK
Cancel
Apply

Figure 2-1. Add/Remove Programs Properties Dialog Box

You can use this same applet to uninstall the NI-CAN software at a later time. Refer to Appendix A, *Uninstalling the Hardware and Software*, for more information.

4. Click on the **Install** button.
5. When prompted, insert the *NI-CAN Software for Windows 95/98/NT (Disk 1 of 3)*, and click on the **Next** button to proceed.
6. The setup wizard guides you through the necessary steps to install the NI-CAN software. You may go back and change values where appropriate by clicking on the **Back** button. If at any time you want to exit the setup, click on the **Cancel** button.
7. Shut down Windows NT and turn off your computer when the setup is complete.

Install the Hardware

This section describes how to install your PXI-8461or PXI-8460 hardware.

Check the Configuration of Your PXI-8461 or PXI-8460

If you plan to use your CAN board in a system where bus power is available, you may want to configure the power supply jumpers on your board. See Appendix B, *Cabling Requirements for PXI-8461 High-Speed CAN*, for more information.

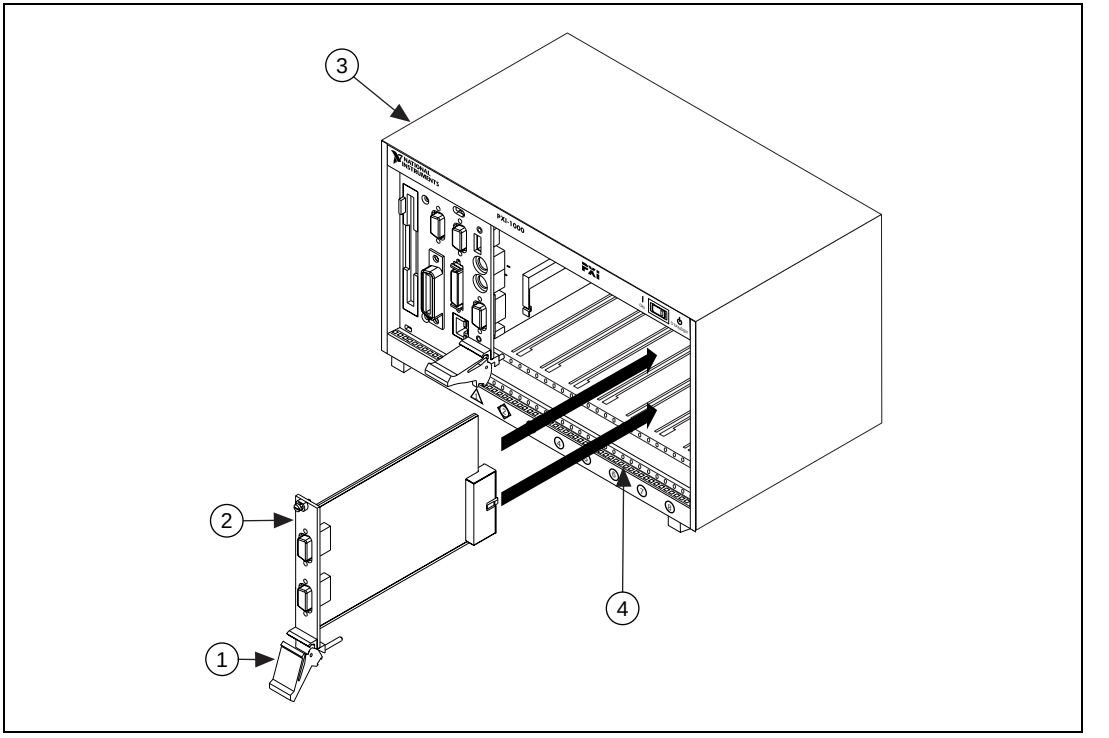
If you are installing a low-speed CAN board, you may need to change the power supply jumpers or termination resistors. See Appendix C, *Cabling Requirements for PXI-8460 Low-Speed CAN*, for more information.

Install Your PXI-8461 or PXI-8460

Caution Before you remove the board from the package, touch the antistatic package to a metal part of your system chassis to discharge electrostatic energy, which can damage several components on your board.

1. Make sure that your PXI or CompactPCI chassis is turned off. Keep the PXI or CompactPCI chassis plugged in so that it remains grounded while you install the PXI board.
2. Choose an unused PXI or CompactPCI 5 V peripheral slot.
3. Remove the filler panel for the peripheral slot you have chosen.
4. Touch a metal part on your chassis to discharge any static electricity that might be on your clothes or body.

5. Insert the PXI board into the selected 5 V slot. Use the injector/ejector handle to fully inject the device into place. Figure 2-2 shows how to install the PXI board into a PXI or CompactPCI chassis.



1	Injector/Ejector Handle (In Down Position)	3	PXI Chassis
2	PXI Board	4	Injector/Ejector Rail

Figure 2-2. Installing the PXI Hardware

6. Screw the front panel of the PXI board to the front panel mounting rail of the PXI or CompactPCI chassis.
7. Turn on your PXI or CompactPCI chassis and start Windows NT.

Connect the Cables

After you have installed your board, connect the CAN cables to your PXI board. Because exact cabling requirements vary for each application, National Instruments does not provide cables. Refer to Appendix B, *Cabling Requirements for PXI-8461 High-Speed CAN*, or Appendix C, *Cabling Requirements for PXI-8460 Low-Speed CAN*, for information about the cabling requirements of the CAN hardware.

Configure the NI-CAN Software

The NI-CAN Configuration utility is located in the Windows NT Control Panel. You can use it to examine or modify the configuration of the NI-CAN software. The context-sensitive online help, available by right-clicking on any of the controls on the configuration utility buttons, includes all the information you need to configure the NI-CAN software.

To use the NI-CAN Configuration utility, you must first log in as `Administrator` or as a user with Administrator privileges. To configure the NI-CAN software, double-click on the **NI-CAN Configuration** icon in the **Control Panel**:

- Windows NT 3.51—Open the **Control Panel** in the **Main** group of the **Program Manager**.
- Windows NT 4.0 or later—Select **Start»Settings»Control Panel**.

Figure 2-3 shows a CAN interface that is working properly. If no interfaces are listed under **NI-CAN Configuration**, refer to the *Missing Board in the NI-CAN Configuration Utility* section in Appendix D, *Troubleshooting and Common Questions*, to resolve the problem.

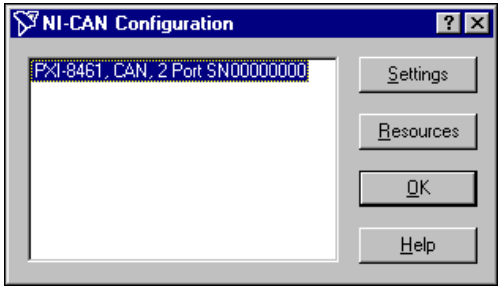


Figure 2-3. PXI-8461 That Is Working Properly

To select a particular interface, click on that interface in the list.

When you install a PXI-8461 or PXI-8460, your computer automatically assigns valid resources to it. Because this resource assignment is automatic, you do not need to use the **Resources** dialog box for the PXI hardware, and you do not need to restart Windows NT.

To view information about the NI-CAN software configuration for the PXI-8461 or PXI-8460, click on the **Settings** button. Figure 2-4 shows the **Settings** dialog box.

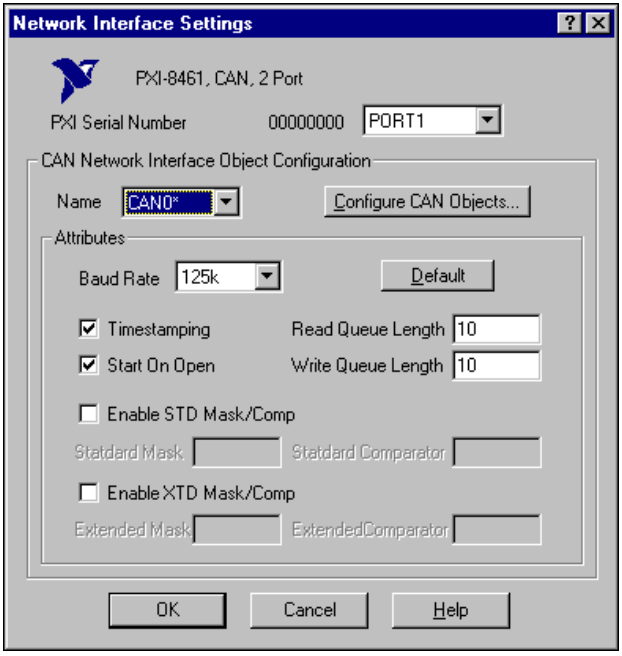


Figure 2-4. NI-CAN Hardware Settings Dialog Box

Each port of the PXI-8461 or PXI-8460 is configured from this tab. Use the drop-down box nearest the top of the tab to select the physical port number to configure. For each port, use the **Name** drop-down box to select the name for the CAN Network Interface Object (`CAN0`, `CAN1`, and so on). You use this name to refer to the physical port from within your NI-CAN application.

To access online help for the NI-CAN Configuration utility, click on the **Help** button. You can also right-click on a specific control and select **What's This?** from the pop-up menu to see context-sensitive help for the item you have clicked on.

When you have finished configuring the NI-CAN software, proceed to Chapter 3, *Verify the Installation*.

3

Verify the Installation

This chapter describes how to verify the hardware and software installation.

You can use the NI-CAN Diagnostic utility, installed with your NI-CAN software, to test the hardware and software installation. The utility verifies that your hardware and software are functioning properly and that the configuration of your hardware does not conflict with anything else in your system.

To run the utility, select the **NI-CAN Diagnostic** item:

- Windows NT 3.51—Double-click on the **NI-CAN Diagnostic** icon in the **NI-CAN Software** group of the **Program Manager**.
- Windows NT 4.0 or later—Select **Start»Programs»National Instruments CAN»NI-CAN Diagnostic**.

When you have started the NI-CAN Diagnostic utility, test your CAN interfaces by clicking on the **Test All** button. You can also test one CAN interface by highlighting it and clicking on the **Test One** button. If the NI-CAN Diagnostic is successful, it puts a checkmark next to the interface and changes its status from **Untested** to **Passed**. If the NI-CAN Diagnostic fails, it puts an X next to the interface, and changes its status from **Untested** to **Failed**. Figure 3-1 shows the NI-CAN Diagnostic utility after it has tested some CAN interfaces.

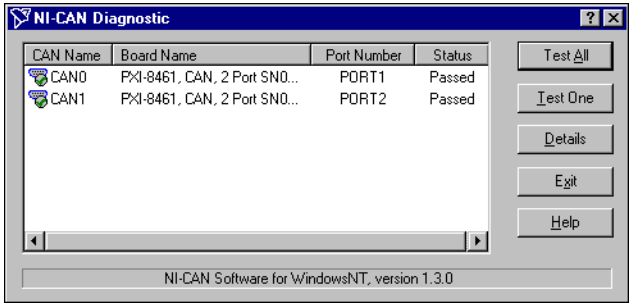


Figure 3-1. NI-CAN Diagnostic Utility after Testing

You can get details about any tested CAN interface by selecting the interface and clicking on the **Details** button. For each failed CAN interface, select it and click on the **Details** button to get a description of the failure. Use that information and the information in Appendix D, *Troubleshooting and Common Questions*, to troubleshoot the problem. Troubleshooting information is also available in the online help for the NI-CAN Diagnostic utility, which you can access by clicking on the **Help** button.

4

Begin to Use the NI-CAN Software

This chapter helps you get started with the NI-CAN software for Windows NT.

Using the NI-CAN Software

The functions provided by the NI-CAN software are similar to those provided by many other device drivers. For example, NI-CAN has open, close, read, and write functions. NI-CAN provides two different levels of access to a CAN network: the CAN Network Interface Object and CAN Objects. Both forms of access support timestamping of incoming data and various forms of queuing.

The CAN Network Interface Object provides low-level access to a CAN network. Each CAN Network Interface Object maps to a specific CAN port, with no limitation on the maximum number of ports or boards you can use (for example, two PXI-8461 two-port interfaces would provide `CAN0` through `CAN3`). You can use this object to transmit and receive entire CAN frames. For example, to transmit a CAN frame, you would specify the outgoing arbitration ID, frame type (data or remote), data length, and data.

The CAN Objects provide higher level access to a CAN network. Each CAN Object maps to a specific data item (arbitration ID), and you can use multiple CAN Objects for a given port. When configuring a CAN Object for use, you specify the arbitration ID, direction of data transfer, data length, and how you want the data to be accessed (such as periodically). For example, you could configure a CAN Object to transmit an outgoing data frame for a specific arbitration ID every 100 ms. After opening this CAN Object, you use the write function to provide data to transmit, and the NI-CAN embedded firmware handles all periodic timing.

For detailed information about the NI-CAN software and functions, refer to the *NI-CAN User Manual* and the *NI-CAN Programmer Reference Manual*.

General Programming Considerations

As you begin developing your Win32 NI-CAN application, remember the following points:

- For your LabVIEW or BridgeVIEW application, you must use the NI-CAN LabVIEW functions in `nican.llb`.
- For your C/C++ application, you must include the NI-CAN header file, `nican.h`, in your source code.
- The NI-CAN software is accessed through the 32-bit DLL, `nican.dll`, either by linking with one of the language interfaces provided with the NI-CAN software, or by using direct DLL entry from other programming environments.
- Several sample CAN applications are included with the NI-CAN software. Use these as a guide for your own application development.

For information about developing your application, refer to the *NI-CAN User Manual*. For detailed information about NI-CAN functions and objects, refer to the *NI-CAN Programmer Reference Manual*.

A

Uninstalling the Hardware and Software

This appendix describes how to uninstall the PXI-8461 or PXI-8460 hardware and the NI-CAN software from Windows NT.

Uninstalling the Hardware from Windows NT

Because Windows NT 3.51 and 4.0 do not maintain hardware information for the board, you just need to physically remove your PXI hardware from your computer. To do so, shut down Windows NT, power off your PXI or CompactPCI chassis, remove any cables attached to your board, and physically remove the board.

Uninstalling the NI-CAN Software from Windows NT

Note The following instructions apply to Windows NT 4.0 only. If you are using Windows NT 3.51, refer to the `readme.txt` file in your NI-CAN directory for information on how to uninstall the NI-CAN software.

Before uninstalling the NI-CAN software, you should remove the PXI boards from your computer, as explained in the previous section.

Complete the following steps to remove the NI-CAN software from Windows NT 4.0:

1. Select the **Add/Remove Programs** icon under **Start»Settings» Control Panel.** A dialog box similar to the one in Figure A-1 appears. This dialog box lists the software available for removal.

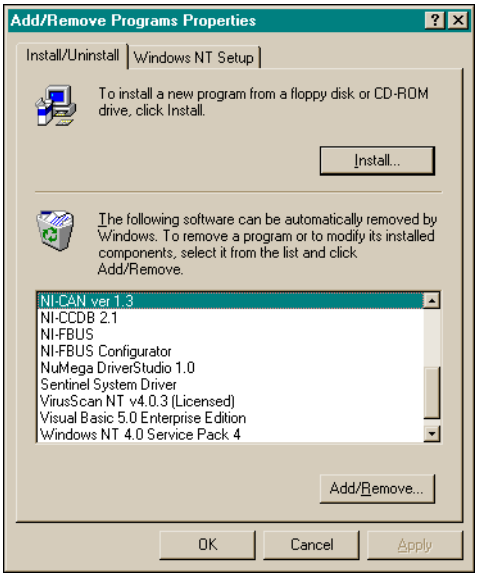

Add/Remove Programs Properties
Install/Uninstall
Windows NT Setup
To install a new program from a floppy disk or CD-ROM drive, click Install.
Install...
The following software can be automatically removed by Windows. To remove a program or to modify its installed components, select it from the list and click Add/Remove.
NI-CAN ver 1.3
NI-CCDB 2.1
NI-FBUS
NI-FBUS Configurator
NuMega DriverStudio 1.0
Sentinel System Driver
VirusScan NT v4.0.3 (Licensed)
Visual Basic 5.0 Enterprise Edition
Windows NT 4.0 Service Pack 4
Add/Remove...
OK
Cancel
Apply

Figure A-1. Add/Remove Programs Properties Dialog Box

2. Select the NI-CAN software you want to remove and click on the **Add/Remove** button. The uninstall program runs and removes all folders, utilities, device drivers, DLLs, and registry entries associated with the NI-CAN software.

The uninstall program removes only items that the installation program installed. If you add anything to a directory that was created by the installation program, the uninstall program does not delete that directory because the directory is not empty after the uninstallation. You need to remove any remaining components yourself.

If you want to reinstall the hardware and software, refer to Chapter 2, *Installation and Configuration*.

B

Cabling Requirements for PXI-8461 High-Speed CAN

This appendix describes the cabling requirements for the hardware.

Cables should be constructed to meet these requirements and the requirements of the other CAN or DeviceNet devices in the network.

Connector Pinouts

Depending on the type of PXI board you are installing, it either has DB-9 D-Sub connector(s) or Combicon-style pluggable screw terminal connector(s).

The 9-pin D-Sub follows the pinout recommended by CiA Draft Standard 102. Figure B-1 shows the pinout for this connector.

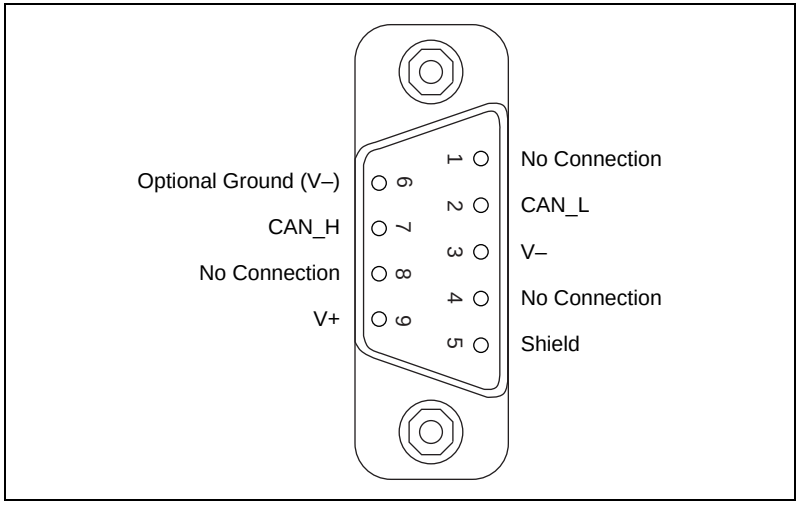


Figure B-1. Pinout for 9-Pin D-Sub Connector

The 5-pin Combicon-style pluggable screw terminal follows the pinout required by the *DeviceNet Specification*. Figure B-2 shows the pinout for this connector.

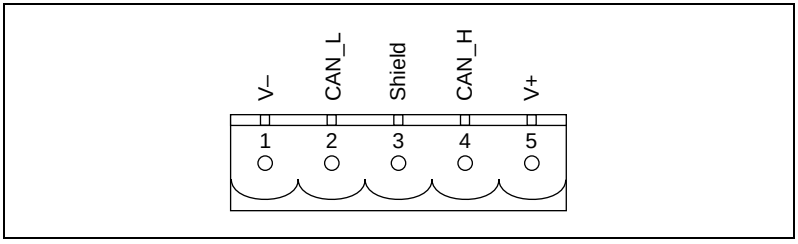


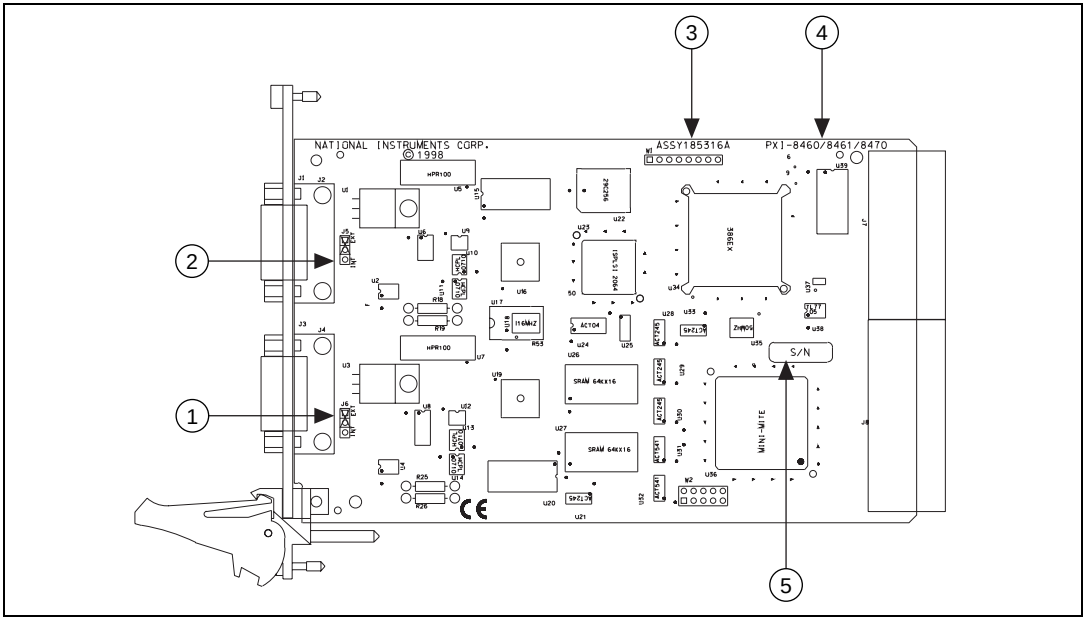
Figure B-2. Pinout for 5-Pin Combicon-Style Pluggable Screw Terminal

CAN_H and CAN_L are signal lines that carry the data on the CAN network. These signals should be connected using twisted-pair cable.

The V+ and V– pins are used to supply bus power to the CAN physical layer if external power is required for the CAN physical layer. If internal power for the CAN physical layer is used, the V– pin serves as the reference ground for CAN_H and CAN_L. See the next section, *Power Supply Information for the High-Speed CAN Ports*, for more information.

Power Supply Information for the High-Speed CAN Ports

For the PXI-8461, a jumper controls the source of power for the CAN physical layer. For the one-port boards and port one of the two-port boards, power is configured with jumper J5. For port two of the two-port boards, power is configured with jumper J6. The location of these jumpers is shown in Figure B-3.



1	Power Supply Jumper J6	3	Assembly Number	5	Serial Number
2	Power Supply Jumper J5	4	Product Name		

Figure B-3. PXI-8461 Part Locator Diagram

Connecting pins 1 and 2 of a jumper configures the CAN physical layer to be powered externally (from the bus cable power). In this configuration, the power must be supplied on the V+ and V– pins on the port connector.

Connecting pins 2 and 3 of a jumper configures the CAN physical layer to be powered internally (from the board). In this configuration, the V– signal serves as the reference ground for the isolated signals.

Figure B-4 shows how to configure your jumpers for internal or external power supplies.

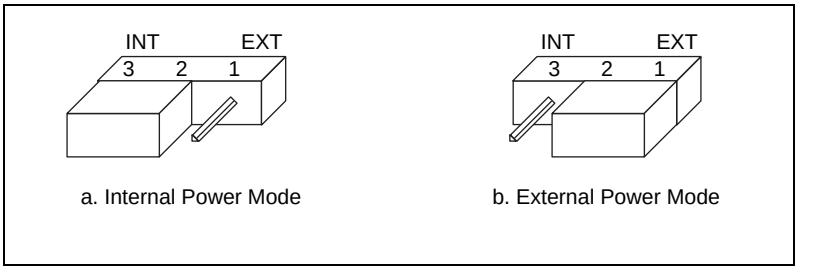


Figure B-4. Power Source Jumpers

The CAN physical layer is still isolated regardless of the power source chosen.

Bus Power Supply Requirements

If the CAN physical layer is powered from a bus power supply, the power supply should be a DC power supply with an output of 10 V to 30 V. The power requirements for the CAN ports for bus-powered configurations are shown in Table B-1. You should take these requirements into account when determining requirements of the bus power supply for the system.

Table B-1. Power Requirements for the CAN Physical Layer for Bus-Powered Versions

Characteristic	Specification
Voltage requirement	V+ 10 to 30 VDC
Current requirement	40 mA typical 100 mA maximum

Cable Specifications

Cables should meet the physical medium requirements specified in ISO 11898, shown in Table B-2.

Belden cable (3084A) meets all of those requirements and should be suitable for most applications.

Table B-2. ISO 11898 Specifications for Characteristics of a CAN_H and CAN_L Pair of Wires

Characteristic	Value
Impedance	108 Ω minimum, 120 Ω nominal, 132 Ω maximum
Length-related resistance	70 mΩ/m nominal
Specific line delay	5 ns/m nominal

Cable Lengths

The allowable cable length is affected by the characteristics of the cabling and the desired bit transmission rates. Detailed cable length requirements can be found in ISO 11898, CiA Draft Standard 102, and the *DeviceNet Specification*.

ISO 11898 specifies 40 m total cable length with a maximum stub length of 0.3 m for a bit rate of 1 Mb/s. The ISO 11898 specification says that significantly longer cable lengths may be allowed at lower bit rates, but each node should be analyzed for signal integrity problems.

Table B-3 lists the DeviceNet cable length specifications.

Table B-3. DeviceNet Cable Length Specifications

Baud Rate	Trunk Length	Drop Length Maximum	Drop Length Cumulative
500 kb/s	100 m (328 ft)	6 m (20 ft)	39 m (128 ft)
250 kb/s	250 m (820 ft)	6 m (20 ft)	78 m (256 ft)
125 kb/s	500 m (1640 ft)	6 m (20 ft)	156 m (512 ft)

Number of Devices

The maximum number of devices that you can connect to a CAN port depends on the electrical characteristics of the devices on the network. If all of the devices meet the requirements of ISO 11898, at least 30 devices may be connected to the bus. Higher numbers of devices may be connected if the electrical characteristics of the devices do not degrade signal quality below ISO 11898 signal level specifications. If all of the devices on the network meet the DeviceNet specifications, 64 devices may be connected to the network.

Cable Termination

The pair of signal wires (CAN_H and CAN_L) constitutes a transmission line. If the transmission line is not terminated, each signal change on the line causes reflections that may cause communication failures.

Because communication flows both ways on the CAN bus, CAN requires that both ends of the cable be terminated. However, this requirement does not mean that every device should have a termination resistor. If multiple devices are placed along the cable, only the devices on the ends of the cable should have termination resistors. See Figure B-5 for an example of where termination resistors should be placed in a system with more than two devices.

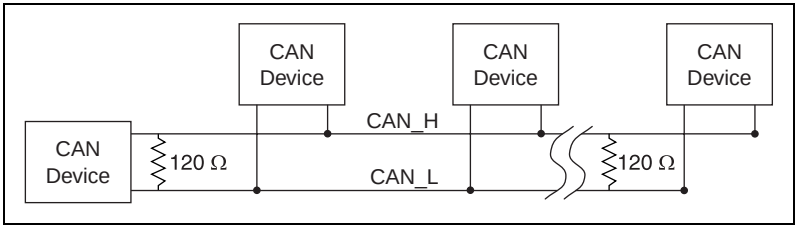


Figure B-5. Termination Resistor Placement

The termination resistors on a cable should match the nominal impedance of the cable. ISO 11898 requires a cable with a nominal impedance of 120 Ω; therefore, a 120 Ω resistor should be used at each end of the cable. Each termination resistor should be capable of dissipating at least 0.25 W of power.

Cabling Example

Figure B-6 shows an example of a cable to connect two CAN devices. For the internal power configuration, no V+ connection is required.

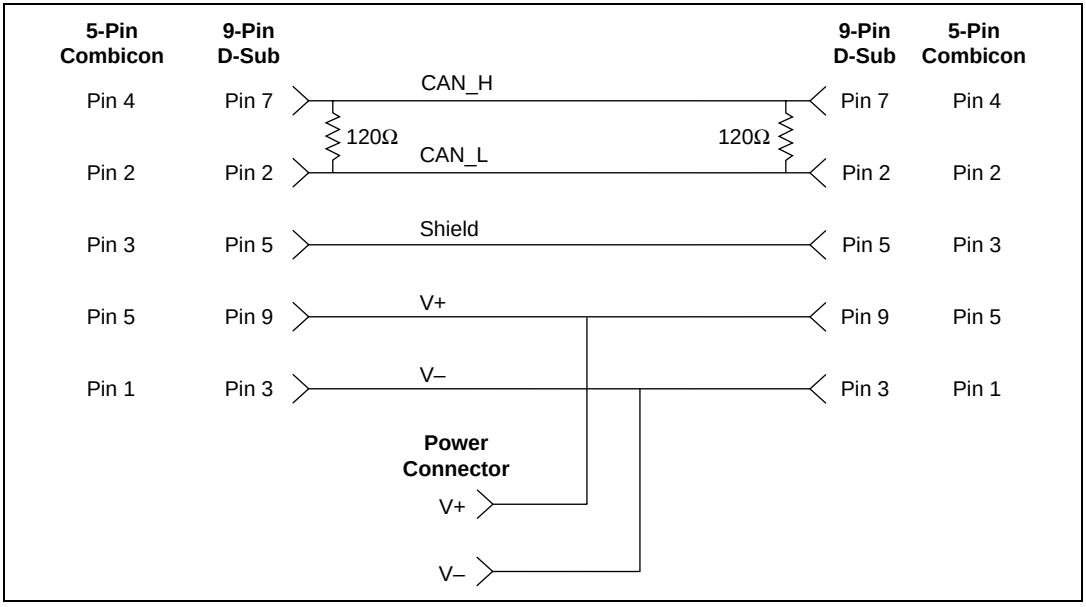


Figure B-6. Cabling Example

C

Cabling Requirements for PXI-8460 Low-Speed CAN

This appendix describes the cabling requirements for the PXI-8460 hardware.

Cables should be constructed to meet these requirements, as well as the requirements of the other CAN devices in the network.

Connector Pinouts

The PXI-8460 has DB-9 D-Sub connector(s). The 9-pin D-Sub follows the pinout recommended by CiA DS 102. Figure C-1 shows the pinout for this connector.

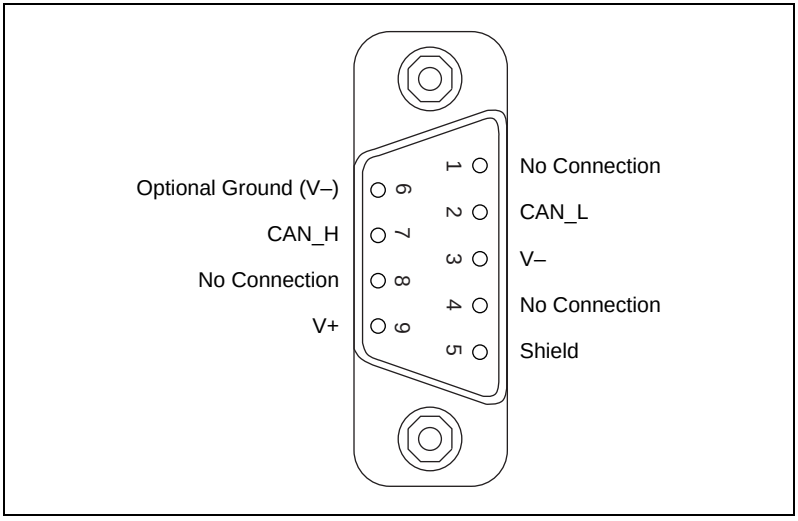


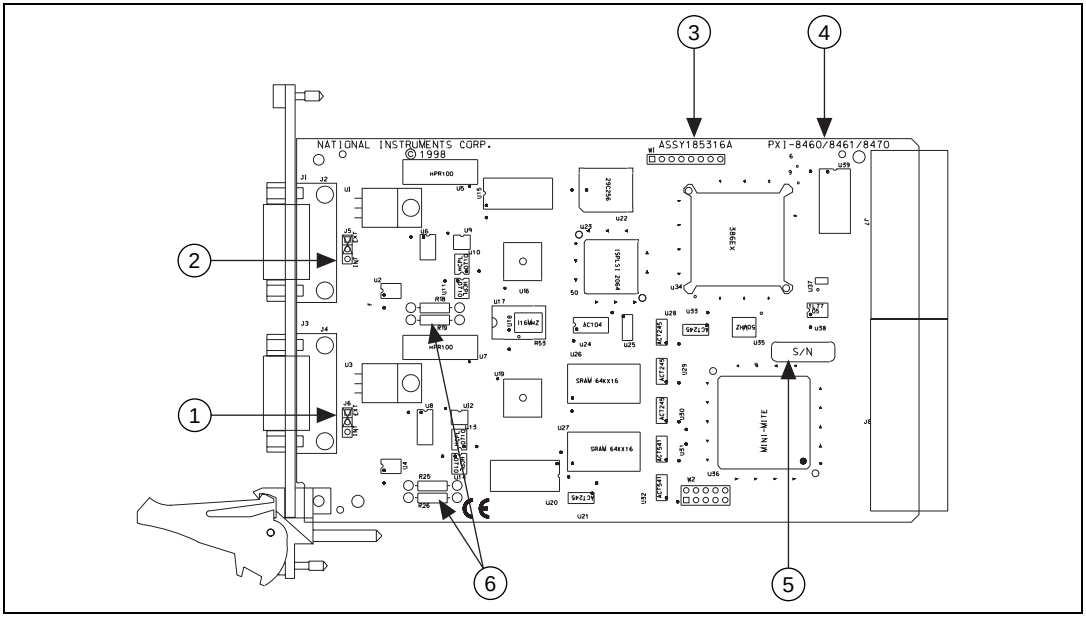
Figure C-1. Pinout for 9-Pin D-Sub Connector

CAN_H and CAN_L are signal lines that carry the data on the CAN network. These signals should be connected using twisted-pair cable.

The V+ and V– pins are used to supply bus power to the CAN physical layer if external power is required for the CAN physical layer. If internal power for the CAN physical layer is used, the V- pin serves as the reference ground for CAN_H and CAN_L. See the next section, *Power Supply Information for the Low-Speed CAN Ports*, for more information.

Power Supply Information for the Low-Speed CAN Ports

For port one of the PXI-8460, power is configured with jumper J5. For port two of the PXI-8460, power is configured with jumper J6. These jumpers are shown in Figure C-2.



1	Power Supply Jumper J6	3	Assembly Number	5	Serial Number
2	Power Supply Jumper J5	4	Product Name	6	Termination Resistor Sockets

Figure C-2. PXI-8460 Parts Locator Diagram

Connecting pins 1 and 2 of a jumper configures the CAN physical layer to be powered externally (from the bus cable power). In this configuration, the power must be supplied on the V+ and V– pins on the port connector.

Connecting pins 2 and 3 of a jumper configures the CAN physical layer to be powered internally (from the card). In this configuration, the V– signal serves as the reference ground for the isolated signals. Even if the CAN physical layer is powered internally, the fault-tolerant CAN transceiver still requires bus power to be supplied in order for it to monitor the power supply (battery) voltage.

Figure C-3 shows how to configure your jumpers for internal or external power supplies.

a. Internal Power Mode b. External Power Mode

Figure C-3. Power Source Jumpers

The CAN physical layer is still isolated regardless of the power source chosen.

Bus Power Supply Requirements

If the CAN physical layer is powered from a bus power supply, the power supply should be a DC power supply with an output of 8 V to 27V. The power requirements for the CAN ports for Bus-Powered configurations are shown in Table C-1. You should take these requirements into account when determining requirements of the bus power supply for the system.

Table C-1. Power Requirements for the Low-Speed CAN Physical Layer for Bus-Powered Versions

Characteristic	Specification
Voltage requirement	V+ 8–27 VDC
Current requirement	40 mA typical 100 mA maximum

Cable Specifications

Cables should meet the physical medium requirements specified in ISO 11519-2, shown in Table C-2.

Belden cable (3084A) meets all of those requirements, and should be suitable for most applications.

Table C-2. ISO 11519-2 Specifications for Characteristics of a CAN_H and CAN_L Pair of Wires

Characteristic	Value
Length-related resistance	90 mΩ/m nominal
Length-related capacitance: CAN_L and ground, CAN_H and ground, CAN_L and CAN_H	30 pF/m nominal

Number of Devices

The maximum number of devices depends on the electrical characteristics of the devices on the network. If all of the devices meet the requirements of ISO 11519-2, at least 20 devices may be connected to the bus. Higher numbers of devices may be connected if the electrical characteristics of the devices do not degrade signal quality below ISO 11519-2 signal level specifications.

Low-Speed Termination

Every device on the low-speed CAN network requires a termination resistor for each CAN data line: R_{RTH} for CAN_H and R_{RTL} for CAN_L. Figure C-4 shows termination resistor placement in a low-speed CAN network.

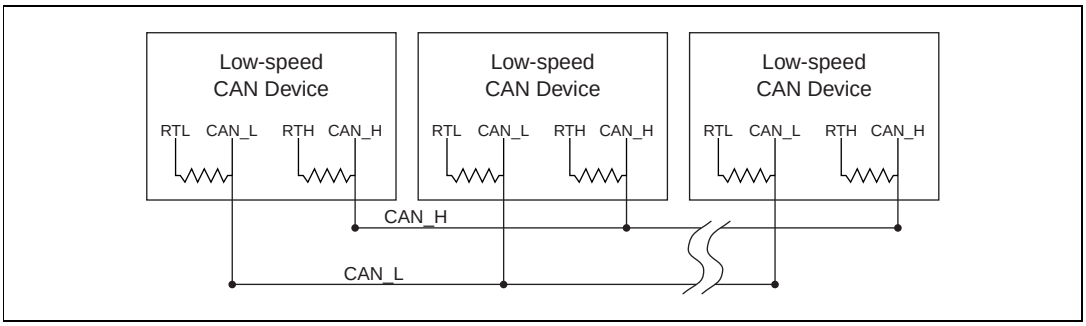


Figure C-4. Termination Resistor Placement for Low-Speed CAN

The following sections explain how to determine the correct resistor values for your PXI-8460, and how to replace those resistors, if necessary.

Determining the Necessary Termination Resistance for Your Board

Unlike high-speed CAN, low-speed CAN requires termination at the low-speed CAN transceiver instead of on the cable. The termination requires one resistor for each CAN line. This configuration allows the Philips fault-tolerant CAN transceiver to detect any of seven network faults. You can use your PXI-8460 to connect to a low-speed CAN network having from two to 32 nodes as specified by Philips (including the port on the PXI-8460 as a node). You can also use the PXI-8460 to communicate with individual low-speed CAN devices. It is important to determine the overall termination of your existing network, or the termination of your individual device, before connecting it to a PXI-8460 port. Philips recommends an overall RTH and RTL termination of 100 to 500 Ω (each) for a properly terminated low-speed network. The overall network termination may be determined as follows:

$$\frac{1}{R_{\text{RTH overall}^{\dagger}}} = \frac{1}{R_{\text{RTH node 1}}} + \frac{1}{R_{\text{RTH node 2}}} + \frac{1}{R_{\text{RTH node 3}}} + \frac{1}{R_{\text{RTH or node n...}}}$$

Philips also recommends an individual device RTH and RTL termination of 500 Ω to 16 kΩ. The PXI-8460 board ships with mounted RTH and RTL values of 510 Ω ±5% per port. The PXI-8460 kit also includes a pair of 15 kΩ ±5% resistors for each port. After determining the termination of your existing network or device, you can use the following formula to indicate which value should be placed on your PXI-8460 board in order to produce the proper overall RTH and RTL termination of 100 to 500 Ω upon connection of the board:

$$R_{\text{RTH overall}*\dagger} = \frac{1}{\left(\frac{1}{R_{\text{RTH of low-speed CAN interface}**}} + \frac{1}{R_{\text{RTH of existing network or device}}}\right)}$$

$*R_{\text{RTH overall}}$ should be between 100 and 500 Ω

$**R_{\text{RTH of low-speed CAN interface}}$= 510 Ω ±5% (mounted) or 15 kΩ ±5% (in kit)

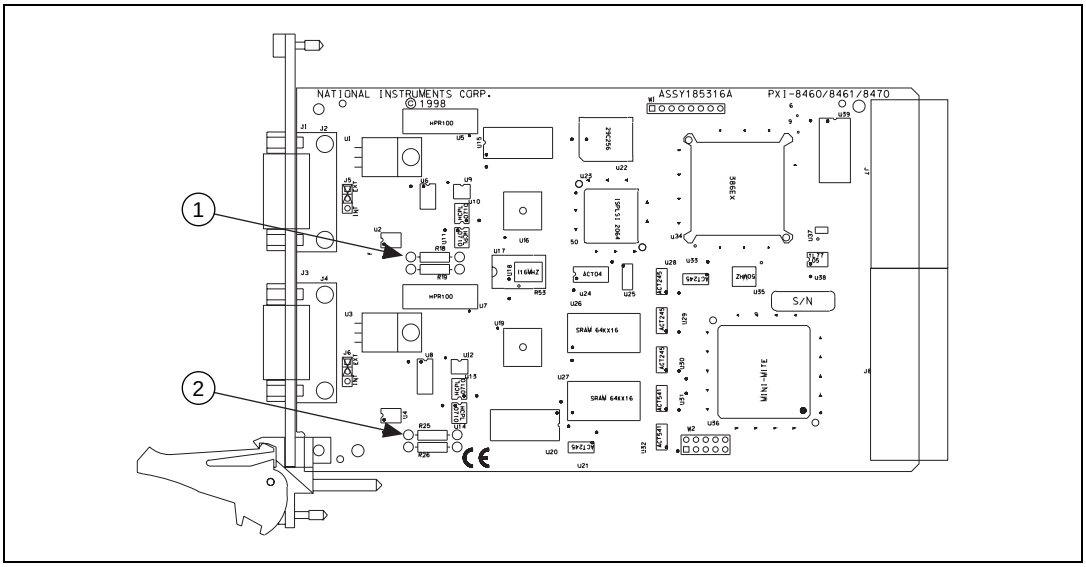
$\dagger R_{\text{RTH}} = R_{\text{RTL}}$

As the formula indicates, the 510 Ω ±5% shipped on your board will work with properly terminated networks having a total RTH and RTL termination of 125 to 500 Ω, or individual devices having an RTH and RTL termination of 500 Ω to 16 kΩ. For communication with a network having an overall RTH and RTL termination of 100 to 125 Ω, you will need to replace the 510 Ω resistors with the 15 kΩ resistors in the kit. Please refer to the next section, *Replacing the Termination Resistors*.

Replacing the Termination Resistors

Follow these steps to replace the termination resistors, after you have determined the correct value in the previous section, *Determining the Necessary Termination Resistance for Your Board*.

1. Remove the termination resistors on your PXI-8460. Figure C-5 shows the location of the termination resistor sockets on a PXI-8460.



1	Port 1 Termination Resistors	2	Port 2 Termination Resistors

Figure C-5. Location of Termination Resistors on a PXI-8460

2. Cut and bend the lead wires of the resistors you want to install. Refer to Figure C-6.

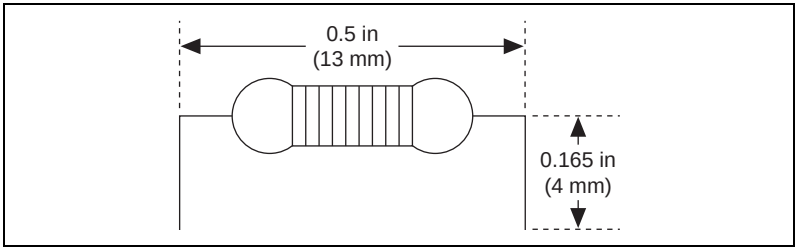


Figure C-6. Preparing Lead Wires of Replacement Resistors

3. Insert the replacement resistors into the empty sockets.
4. Refer to *Install the Hardware*, in Chapter 2, *Installation and Configuration*, to complete the hardware installation.

Cabling Example

Figure C-7 shows an example of a cable to connect two low-speed CAN devices. For the internal power configuration, the V+ connection is required for the low-speed transceiver to operate as specified in the Philips data sheet.

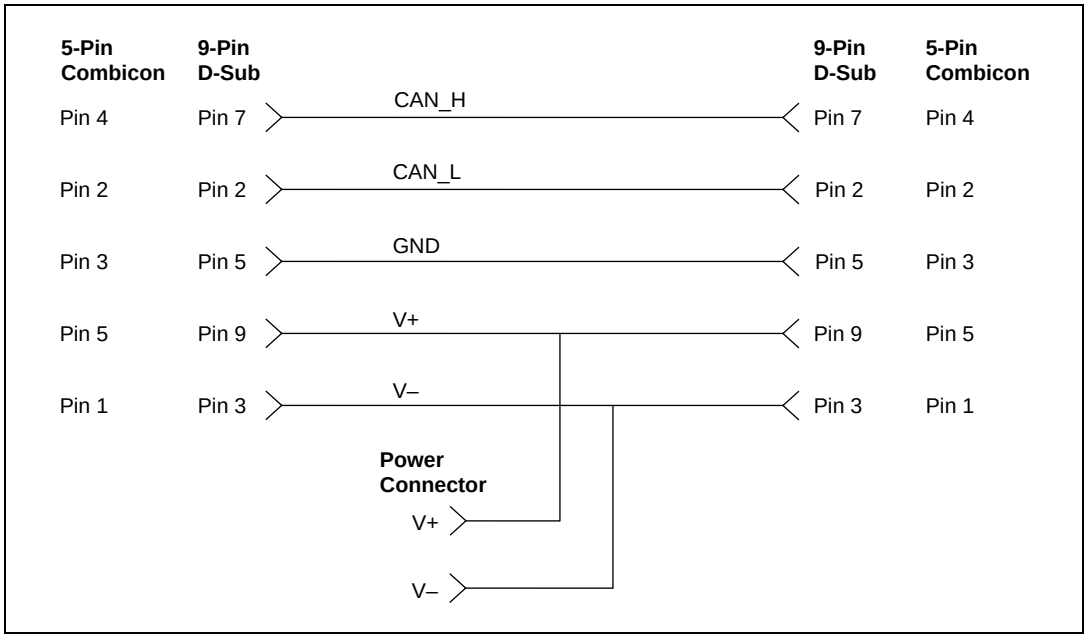


Figure C-7. Cabling Example

D

Troubleshooting and Common Questions

This appendix describes how to troubleshoot problems and answers some common questions.

Missing Board in the NI-CAN Configuration Utility

The NI-CAN Configuration utility contains configuration information for all of the CAN hardware it is aware of that is installed in your system. To start the NI-CAN Configuration utility, double-click on the **NI-CAN Configuration** icon in the **Control Panel**:

- Windows NT 3.51–Open the **Control Panel** in the **Main** group of the **Program Manager**.
- Windows NT 4.0 or later–Select **Start»Settings»Control Panel**.

If your board is not listed under **NI-CAN Configuration**, the board is not properly installed. For the PXI-8461 or PXI-8460, this means that the board is not physically present in the system. If your board is firmly plugged into its slot and the problem persists, contact National Instruments.

Diagnostic Utility Failures

The following sections explain common error messages generated by the NI-CAN Diagnostic utility.

Resource Errors

This error occurs if the memory resource or interrupt resource assigned to a board conflicts with the resources being used by other hardware in the system. If a resource error occurs, click on the **Resources** button in the NI-CAN Configuration utility to view the board resources. For the PXI-8461 or PXI-8460, if legacy hardware in your system is using the resources, change the resource configuration of the legacy hardware. If you need help, refer to the documentation that came with your hardware. If the problem persists, contact National Instruments.

NI-CAN Software Problem Encountered

This error occurs if the NI-CAN Diagnostic utility detects that it is unable to communicate correctly with the hardware using the installed NI-CAN software. If you get this error, shut down your computer, restart it, and run the NI-CAN Diagnostic utility again. If the problem persists, try reinstalling the NI-CAN software for Windows NT.

Missing Board in Diagnostic Utility

If your board is physically installed in your system, but is not listed in the NI-CAN Diagnostic utility, check to see if the NI-CAN Configuration utility has detected the board. For more information, refer to the *Missing Board in the NI-CAN Configuration Utility* section earlier in this appendix.

Hardware Problem Encountered

This error occurs if the NI-CAN Diagnostic utility detects a defect in the hardware. If you get this error, write down the numeric code shown with the error and contact National Instruments. Depending on the cause of the hardware failure, you may need to repair or replace your board.

Common Questions

How can I determine which type of CAN hardware I have installed?

Run the NI-CAN Configuration utility. To run the utility, select **Start»Settings»Control Panel»NI-CAN Configuration**. If any hardware is correctly installed, it is listed under **National Instruments CAN Interfaces**.

How can I determine which version of the NI-CAN software I have installed?

Run the NI-CAN Diagnostic utility. To run the utility, select the **NI-CAN Diagnostic** item under **Start»Programs»National Instruments CAN**. The NI-CAN Diagnostic utility displays information about the version of the NI-CAN software currently installed.

How many PXI-8461 or PXI-8460 boards can I configure for use with my NI-CAN software?

The NI-CAN software for Windows NT can be configured to communicate with up to 10 boards.

How do I connect a CAN cable to my CAN port?

You will need to use an appropriate cable. For information about cabling requirements for National Instruments CAN hardware, refer to Appendix B, *Cabling Requirements for PXI-8461 High-Speed CAN* or Appendix C, *Cabling Requirements for PXI-8460 Low-Speed CAN*.

Are interrupts required for the PXI-8461 and PXI-8460?

Yes, one interrupt per board is required.

What do I do if the NI-CAN Diagnostic utility fails with an error?

Refer to the *Diagnostic Utility Failures* section in this appendix for specific information about what might cause the NI-CAN Diagnostic utility to fail. If you have already completed the troubleshooting steps, contact National Instruments.

How do I use an NI-CAN language interface?

For information about using NI-CAN language interfaces, refer to Chapter 3, *Developing Your Application*, in the *NI-CAN User Manual*.

How do I use NI-CAN from within LabVIEW or BridgeVIEW?

For information about using NI-CAN from within LabVIEW or BridgeVIEW, refer to Chapter 3, *Developing Your Application*, in the *NI-CAN User Manual*.

Why does the uninstall program leave some components installed?

The uninstall program removes only items that the installation program installed. If you add anything to a directory that was created by the installation program, the uninstall program does not delete that directory because the directory is not empty after the uninstallation. You must remove any remaining components yourself.

E

Specifications

This appendix describes the physical characteristics of the hardware and the recommended operating conditions.

PXI-8461 One Port and Two Port

Dimensions..... PXI 3U Module
100 by 160 mm
(3.94 by 6.30 in.)

Power requirement ..... +5 VDC 500 mA typical

I/O connector..... 9-pin D-Sub for each port
(standard)
or
5-pin Combicon-style pluggable
DeviceNet screw terminal

Operating environment

- Component temperature..... 0 to 55 °C
- Relative humidity..... 10% to 90%, noncondensing

Storage environment

- Temperature ..... –20 to 70 °C
- Relative humidity..... 10% to 90%, noncondensing

PXI-8460 One Port and Two Port

Dimensions..... PXI 3U Module
100 by 160 mm
(3.94 by 6.30 in.)

Power requirement ..... +5 VDC 500 mA typical

I/O connector..... 9-pin D-Sub for each port

Operating environment

Component temperature .....0 to 55 °C

Relative humidity .....10% to 90%, noncondensing

Storage environment

Temperature.....–20 to 70 °C

Relative humidity .....10% to 90%, noncondensing

High-Speed CAN Port Characteristics for Bus-Powered Ports

Power requirement.....10–30 V, 40 mA typical
100 mA maximum

Isolation .....500 VDC optical

Low-Speed CAN Port Characteristics for Bus-Powered Ports

Power requirement.....8–27 V, 40 mA typical
100 mA maximum

Isolation .....500 VDC optical

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Technical Support Resources

This appendix describes the comprehensive resources available to you in the Technical Support section of the National Instruments Web site and provides technical support telephone numbers for you to use if you have trouble connecting to our Web site or if you do not have internet access.

NI Web Support

To provide you with immediate answers and solutions 24 hours a day, 365 days a year, National Instruments maintains extensive online technical support resources. They are available to you at no cost, are updated daily, and can be found in the Technical Support section of our Web site at `www.natinst.com/support`.

Online Problem-Solving and Diagnostic Resources

- **KnowledgeBase**—A searchable database containing thousands of frequently asked questions (FAQs) and their corresponding answers or solutions, including special sections devoted to our newest products. The database is updated daily in response to new customer experiences and feedback.
- **Troubleshooting Wizards**—Step-by-step guides lead you through common problems and answer questions about our entire product line. Wizards include screen shots that illustrate the steps being described and provide detailed information ranging from simple getting started instructions to advanced topics.
- **Product Manuals**—A comprehensive, searchable library of the latest editions of National Instruments hardware and software product manuals.
- **Hardware Reference Database**—A searchable database containing brief hardware descriptions, mechanical drawings, and helpful images of jumper settings and connector pinouts.
- **Application Notes**—A library with more than 100 short papers addressing specific topics such as creating and calling DLLs, developing your own instrument driver software, and porting applications between platforms and operating systems.

Software-Related Resources

- **Instrument Driver Network**—A library with hundreds of instrument drivers for control of standalone instruments via GPIB, VXI, or serial interfaces. You also can submit a request for a particular instrument driver if it does not already appear in the library.
- **Example Programs Database**—A database with numerous, non-shipping example programs for National Instruments programming environments. You can use them to complement the example programs that are already included with National Instruments products.
- **Software Library**—A library with updates and patches to application software, links to the latest versions of driver software for National Instruments hardware products, and utility routines.

Worldwide Support

National Instruments has offices located around the globe. Many branch offices maintain a Web site to provide information on local services. You can access these Web sites from `www.natinst.com/worldwide`.

If you have trouble connecting to our Web site, please contact your local National Instruments office or the source from which you purchased your National Instruments product(s) to obtain support.

For telephone support in the United States, dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 03 9879 5166, Austria 0662 45 79 90 0, Belgium 02 757 00 20,
Brazil 011 284 5011, Canada (Calgary) 403 274 9391,
Canada (Ontario) 905 785 0085, Canada (Québec) 514 694 8521,
China 0755 3904939, Denmark 45 76 26 00, Finland 09 725 725 11,
France 01 48 14 24 24, Germany 089 741 31 30, Greece 30 1 42 96 427
Hong Kong 2645 3186, India 91805275406, Israel 03 6120092,
Italy 02 413091, Japan 03 5472 2970, Korea 02 596 7456,
Mexico (D.F.) 5 280 7625, Mexico (Monterrey) 8 357 7695,
Netherlands 0348 433466, Norway 32 27 73 00, Singapore 2265886,
Spain (Barcelona) 93 582 0251, Spain (Madrid) 91 640 0085,
Sweden 08 587 895 00, Switzerland 056 200 51 51,
Taiwan 02 2377 1200, United Kingdom 01635 523545

Glossary

Prefix	Meaning	Value
n-	nano-	10^{-9}
m-	milli-	10^{-3}
k-	kilo-	10^{3}
M-	mega-	10^{6}

°	degrees
Ω	ohms
%	percent
A	amperes
ANSI	American National Standards Institute
b	bits
B	bytes
C	Celsius
CAN	Controller Area Network
CiA	CAN in Automation
DC	direct current
DLL	dynamic link library
FCC	Federal Communications Commission
ft	feet
HMI	Human Machine Interface
Hz	hertz
IEEE	Institute of Electrical and Electronic Engineers
in.	inches
IRQ	interrupt request

ISO	International Standards Organization
LED	light-emitting diode
m	meters
PC	personal computer
PCI	peripheral component interconnect
PCMCIA	Personal Computer Memory Card International Association
PLC	Programmable Logic Controller
RAM	random-access memory
resource	hardware settings used by National Instruments CAN hardware, including an interrupt request level (IRQ) and an 8 KB physical memory range (such as D0000 to D1FFF hex)
s	seconds
V	volts
VDC	volts direct current
VXI	VME eXtensions for Instrumentation
W	watts